

# INVESTIGATION OF GAS EFFECTS ON CRYOCOOLER RESONANCE CHARACTERISTICS

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Cryocooler thermal and vibrational performance is determined, fundamentally, by the dynamic interactions between the mechanical system and the working fluid. This paper explores the effect of working-fluid characteristics on the mechanical response of the cooler. A theoretical discussion of these effects shows that a classic single-degree-of-freedom spring-mass-damper model does not capture the full frequency dependence of the mechanical response. Specifically, working-fluid characteristics dominate at **high** frequencies, and mechanical system characteristics dominate at lower frequencies. The above explanation of the system interactions is validated by data collected from two pulse-tube coolers characterized under the Jet Propulsion Laboratory's extensive program of cryocooler testing and characterization. Experimental measurements on a TRW Model 3503 cooler and a TRW Model 60K cooler confirm the theory for two modes of piston motion (slosh and head-to-head) at cryogenic and ambient temperatures. Finally, the theoretical model provides a framework from which resonant parameters are extracted from the experimental data.

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